



## A circular finite-element model reconstruction in electrical impedance tomography

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A CIRCULAR FINITE-ELEMENT MODEL RECONSTRUCTION IN ELECTRICAL IMPEDANCE TOMOGRAPHY

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ABSTRACT

A circular finite element model utilising triangular picture elements has been constructed using the reconstruction method described by Yorkey et al (1). Application of the model to examples of simulated reconstructed pictures illustrates its properties with regard to sensitivity, contrast and shape of object.

1. INTRODUCTION

Compared to the many imaging techniques which have evolved during the last decades the electrical impedance tomography seems quite inferior. The picture resolution is relatively poor, and no good accuracy in the resistivity estimation is to be expected, partly because of electrical anisotropy of the tissue, and partly because of inconsistency between the three-dimensional body and the two-dimensional models normally used. Nevertheless, the technique is attractive because it is easy to apply, non invasive, painless, without risk to the patient and cheap. Finally it depicts a property of the tissues not covered by other imaging techniques. The large variations in tissue resistivity counteract somewhat the inaccuracy of the method (2,3).

2. RECONSTRUCTION OF A CIRCULAR FINITE-ELEMENT MODEL BASED ON A TRIANGULAR PICTURE ELEMENT

With the purpose of obtaining more natural boundary conditions of the finite-element model for the above reconstruction method (1), a triangular resistor picture element, shown in Fig. 1, is developed. Then the characteristics of this model: sensitivity, contrast, and importance of object shape to be reconstructed are investigated by simulation and the following questions are examined:

Sensitivity: Difference in reconstruction properties with respect to changes in resistivity in the central part of the model compared to the peripheral part shading of centrally placed objects by peripheral high resistivity tissues.

Contrast: Reconstruction dependence on the contrast conditions.

Shape of object: Reconstruction dependence on the object size and shape.

The following reconstruction parameters are used for the tests shown in Figs. 3-8:

obj : resistivity of object  $\Omega$  m  
bag : background resistivity  $\Omega$  m  
ro : initial homogeneous resistivity  $\Omega$  m  
it : number of reconstruction iterations  
necessary to obtain an error  $< 0.01$ .

The resistivity scale of the reconstructed pictures is shown in Fig. 2. In each picture the true object is outlined. Fig. 3 shows a perfect reconstruction of a symmetrical object positioned in the center of the finite-element model. In Fig. 4 it is demonstrated that a symmetrical object positioned off center in the model is reconstructed exhibiting shadows. A low contrast reconstruction is shown in Fig. 5 and a high contrast in Fig. 6. Here the reconstructed resistivity value is in the range of 10-20  $\Omega$  m. Tests on object shape are shown in Figs. 7-8. Here a minimum resolution object is perfectly reconstructed in Fig. 7 and a large bar shaped object is reconstructed with some shadows in Fig. 8.

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Comparing reconstruction algorithms for electrical impedance tomography.  
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- (2) : Brown, Barber and Seagar  
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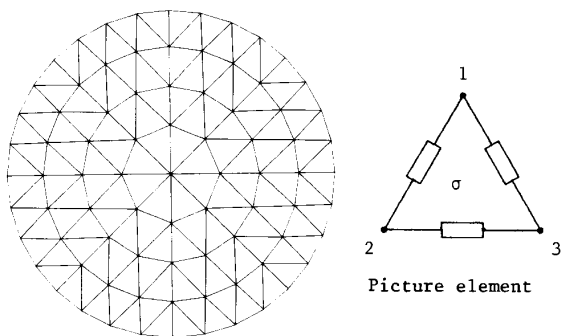


Fig. 1. Circular finite-element model.

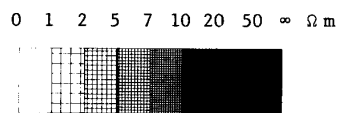


Fig. 2. Resistivity scale of reconstructed pictures.

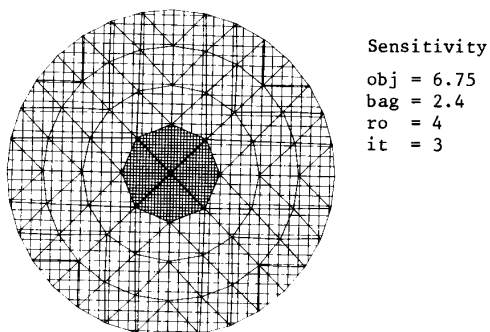


Fig. 3. Central positioned object.

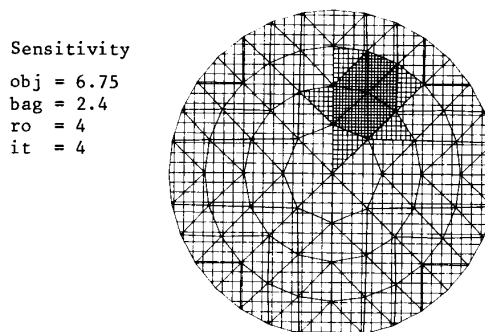


Fig. 4. Non central positioned object.

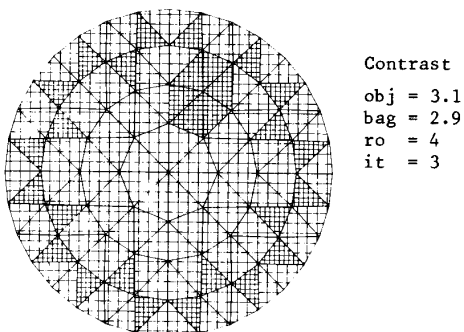


Fig. 5. Low contrast object.

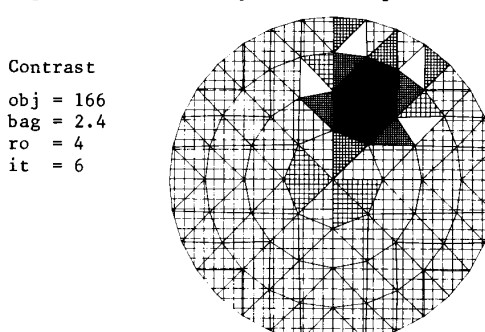


Fig. 6. High contrast object.

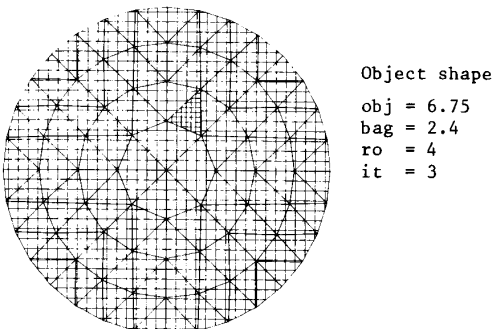


Fig. 7. Minimum resolution object.

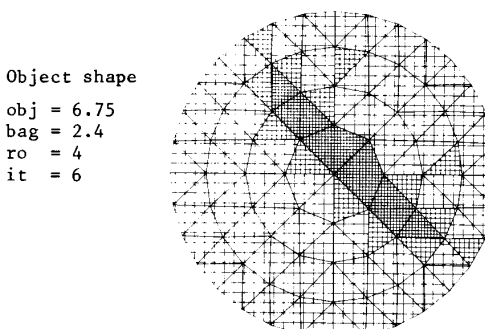


Fig. 8. Large bar shaped object.